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Original Research Article

Comparison of retinal nerve fiber thickness in emmetropes, myopes and hyperopes using optical coherence tomography

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ABSTRACT

Aim: Aim of this study was to analyze retinal nerve fiber layer thickness by using spectral domen Optical Coherence Tomography (OCT) in different refractive status (emmetrops, myopes and hypermetrops).

Materials and Methods: A cross-sectional study involved 150 patients aged 18-40, with and without refractive errors. Three groups (Emmetropic, Myopic, Hypermetropic) were tested using spectral domain OCT after pupil dilation, comparing RNFL thickness.

Result: In this study, 150 participants were categorized into three groups: emmetropia, myopia, and hypermetropia. The age group most represented was 21-25 years, comprising 35.3% of the sample. Of the total, 80 were male (53.3%), and 70 were female. Among males, 22 patients were emmetropia, myopia in 31 and hypermetropia in 27. The mean axial length for emmetropia was 23.54 ± 0.48 SD, myopia was 24.53 ± 0.48 and hypermetropia was 22.36 ± 1.11. Hypermetropia was further categorized into low-grade 22.49 ± 1.06 SD, moderate 22.26 ± 1.12 SD and high-grade 22.45 ± 1.00 based on axial length.

Conclusion: Myopic individuals exhibited significant RNFL thinning, particularly in the inferior and superior quadrants, resembling early glaucoma-related changes. This has implications for glaucoma suspect evaluations.

1. Introduction

The retinal nerve fiber layer (RNFL) comprises of astrocytes, neuroglia and ganglion cell axons. These ganglion cell axons form the optic nerve by converging at the optic disc. The peripapillary RNFL will be thickest in the inferior part followed by superior, then nasal and temporal part.The shape of the neuro-retinal rim, the size of the retinal arterioles, the placement of the foveola, and the architecture of the lamina cribrosa all correlate with this distribution. With advancing age, the RNFL transparency diffusely declines without favoring particular fundus locations or manifesting isolated abnormalities. In addition to age-related loss, all optic nerve illnesses cause a broad or localized decrease in the RNFL's visibility.[1] They are typically present in 20% of all glaucoma eyes, but they can also be a sign of other ocular conditions such as optic disc drusen, toxoplasmoticretino choroidal marks, chronic papilledema, or multiple sclerosis-related optic neuritis. If they are aberrant, then they are the eyes that are constantly present. For initial glaucoma assessment and also in glaucoma eyes with tiny optic discs, RNFL assessment is very beneficial.[1,2]

A sensitive marker of initial glaucomatous impairment is the retinal nerve fiber layer (RNFL). Currently, optical coherence tomography (OCT) has been widely employed

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for the assessment and follow-up of glaucoma and other ocular neuropathies due to its outstanding capacity to evaluate peripapillary RNFL thickness.[3] Refractive errors, particularly myopia, are widely established to be significant risk factors for the emergence of various kinds of glaucoma. In myopes, the peripapillary RNFL is thinner in the superior and inferior quadrants and thicker throughout the nasal quadrant. The evaluation of damaged optic nerves in pre-perimetric glaucoma is now done using OCT.[4] OCT can be a useful technique in susceptible/high-risk refractive errors for accurately predicting glaucoma before the changes to the optic disc become obvious, in addition to its benefits for macular disorders. As RNFL thickness evaluation by OCT is useful for future follow-up, it should be included in the regular evaluation of patients with refractive problems.[5–7] The development of optical coherence tomography (OCT) has enabled the imaging and measurement of the various aspects of the retina and optical disc. The high resolution of spectral domain OCT (SDOCT) can be used to measure and quantify the retinal nerve fiber thickness by calculating the area between the internal limiting membrane and the RNFL border.[8] The current study aims to measure the retinal nerve fiber thickness and compare the retinal nerve fiber layer thickness in emmetropes, myopes, and hyperopes.[9]

2. Materials and Methods

This was a hospital based cross-sectional study with duration of 1.5 years in which all patients with and without refractive errors between the age group 18-40 years attending Vinayaka Mission's Kirupananda Variyar Medical College & Hospital were enrolled in the study after obtaining written informed consent. One hundred fifty patients were screened in the study. 150 patients were subdivided into 3 groups, 50 members in each group as follows

Group 1: Emmetropes

Group 2: Myopes (more than -2 D, including myopic astigmatism andLong-standing myopes)

Group 3: Hyperopes (more than +2D, including Hyperopic astigmatism andLong-standing Hyperopes)

Relevant ocular history was obtained, and the patients were examined thoroughly for visual acuity using Snellen's chart, Refraction, Intraocular pressure measured by Goldman's Applanation Tonometer, slit lamp examination for anterior segment, dilated fundus examination by Slit lamp with 90D lens, direct and indirect ophthalmoscope. Keratometry using Bausch and Lomb manual kerato-meter and axial length using A-scan. Fundus photograph is taken with a Fundus camera. All patients are tested after pupil dilatation using spectral domain OCT. First, retinal nerve fiber layer thickness is measured using an optic disc map scan. Then the values are compared among emmetropes, myopes and hyperopes.

2.1. *Inclusion criteria*

Patients of the age group between 18 – 40 years, both genders, all races, with and without refractive errors.

2.2. *Exclusion criteria*

1. Patients less than 18 years and more than 40 years
2. Myopes less than -2D, hyperopes less than +2D
3. Patients with congenital and developmental anomalies
4. Patients with a history of glaucoma, keratoconus, underlying retinal pathologies like diabetic retinopathy and hypertensive retinopathy and ocular diseases, such as uveitis.
5. Post-refractive surgery patients, Therapeutic ocular surgeries.

2.3. *Statistical analysis*

Descriptive statistics were reported using mean and Standard deviation for continuous variables, numbers and percentages for the categorical variables. Parametric student T-test was used to compare the measurement of retinal nerve fiber layer thickness between emmetropes, myopes & hyperopes.

3. Results

Patients in the current study were characterized into three groups; emmetropia, myopia, and hypermetropia. The age group between 21-25 was most affected, with 35.3% of all three, followed by the age group between 26-30 (27.3%). Emmetropia was majorly observed in the 21-25 years of age with 14 patients (38.0%), followed by myopia in the same age group of 21-25 years with 19 patients (38.0%), and hypermetropia in 15 patients (30.0%) respectively (Figure 1). Of 150 patients, 80 were male, 53.3% of the total, whereas 70 were female. Emmetropia was most commonly reported in females with 28 patients, myopia in 19 patients, and hypermetropia in 23 patients.

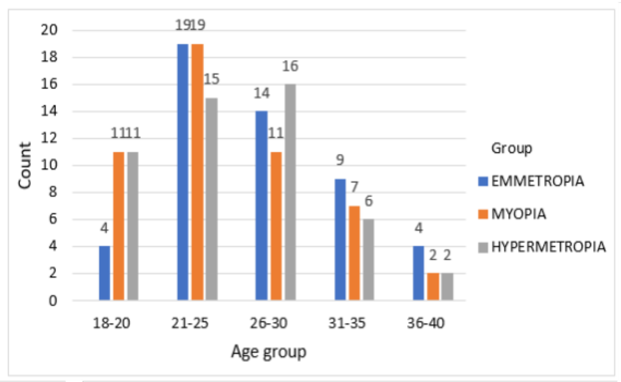

Figure 1: Age wise distribution

In the male group, emmetropia was seen in 22 patients, followed by 31 patients with myopia and 27 with hypermetropia (Figure 2)

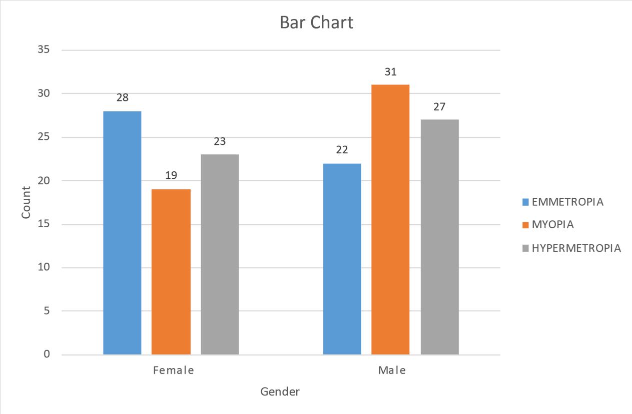

Figure 2: Gender wise distribution

A significant difference in axial length between the three groups with a p-value <0.0001. In the following three groups, the emmetropia mean axial was 23.54 ± 0.48 SD, the myopia axial length mean was 24.53 ± 0.48, and the hypermetropia means axial length was 22.36 ± 1.11 (Table 1).

Table 1: Axial length comparison

Axial length	Mean	Std. Deviation	P value
Emmetropia	23.54	0.48	<0.0001
Myopia	24.53	0.48	
Hypermetropia	22.36	1.11	

The current study assessed the axial length with the grade of the disease, which revealed that myopia with moderate grade was most prevalent among patients with a mean of 24.68 ± 0.55 SD, followed by low-grade myopia with a mean of 24.67 ± 0.44 SD. In addition, low-grade hypermetropia was seen with a mean axial length of 22.49 ± 1.06 SD, followed by moderate hypermetropia ween with a mean axial length of 22.26 ± 1.12 SD, and high-grade hypermetropia with a mean axial length of 22.45 ± 1.00 (Table 2).

Using OCT method for evaluation of RNFL thickness in patients. The findings were categorized into 4 as Inferior, Superior, Nasal and temporal with grading as low, moderate and high in myopia and hypermetropia among patients (Table 3)

The study found a significant difference was in the inferior RNFL thickness between the three groups; emmetropia (mean 124.52 ± 17.08 SD), followed by myopia (mean 109.70 ± 14.49 SD), and hypermetropia (mean 123.96 ± 17.31 SD) with a p-value <0.0001, where the study did not find a significant difference in nasal RNFL thickness in the emmetropia, myopia, and hypermetropia group (p-value = 0.011). Patients with emmetropia, myopia, and hypermetropia reported no significant difference and correlation for temporal RNFL thickness (p-value = 0.201).

4. Discussion

The retinal nerve fiber layer (RNFL) comprises of astrocytes, neuroglia and ganglion cell axons. These ganglion cell axons form the optic nerve by converging at the optic disc. The peripapillary RNFL will be thickest in the inferior part followed by superior, nasal and temporal part.[10] The relationship between RNFL thickness and myopia has been extensively investigated. However, the RNFL thickness could vary based on the refractive errors of the eye; hence it is essential to assess the correlation between RNFL thickness with emmetropia, hypermetropia and myopia.[11,12]

This study was to compare RNFL thickness among patients with emmetropia and refractive errors namely myopia and hypermetropia in the age group of 18-40 years. Of the total participants, the refractive error was 35.3% in the age group of 21-25 years, 27.3% in the age group of 26-30 years of age. Emmetropia was common in females and myopia was common in males.

The evaluation of axial length in patients showed a significant difference between emmetropia, myopia, and hypermetropia (p-value <0.0001). A similar study finding was reported by Shin et al., on analysis with simple linear regression, before and after adjustment of the ocular magnification, as the axial length increased and spherical equivalent decreased, the thickness of the temporal RNFL thickness increased and that of superior, nasal and inferior nasal RNFL decreased.[13] Patients with emmetropia, myopia, and hypermetropia reported similar observations in other studies.[11,14,15] In addition, a mean (I-J) difference was reported between the three groups; emmetropia, myopia, and hypermetropia (p-value <0.0001).

The axial length and disease grade comparison did not report a significant difference; however, the assessment revealed that patients were more prevalent with a moderate grade of myopia with a mean of 24.68 ± 0.44 SD, and low-grade hypermetropia was most common in this age group. As the level of myopia increased, the thickness of peripapillary RNFL decreased[12,14]

The OCT findings revealed a decrease in RNFL thickness in the categorized reason; inferior, superior, nasal, and temporal in patients with emmetropia.[16] Similar findings were also reported by patients with myopia concerning a decrease in the mean RNFL thickness in the inferior quadrant, followed by the superior region, nasal, and

Table 2: Axial length and disease grade

				Axial length	
				Mean	**Standard deviation**
	Emmetropia			23.54	0.48
			Low	24.67	0.44
	Myopia	Grade	Moderate	24.68	0.55
Group			High	24.15	0.21
			Low	22.49	1.06
	Hypermetropia	Grade	Moderate	22.26	1.12
			High	22.45	1.00

Table 3: Mean and standard deviation of RNFL thickness among Emmetropia, Myopia, Hypermetropia

	Grade	Inferior		Superior		Nasal		Temporal	
		Mean	**Standard deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Emmetropia	-	124.52	17.08	120.10	12.32	72.83	12.76	60.81	7.11
	Low	113.79	13.08	86.65	18.01	70.33	14.52	60.80	6.15
Myopia	Moderate	108.15	14.10	94.36	22.14	63.95	8.35	58.54	12.34
	High	112.15	13.36	108.40	1.56	63.70	3.82	46.60	1.98
	Low	123.86	20.99	117.69	26.68	68.93	9.81	57.08	11.65
Hypermetropia	Moderate	127.33	4.32	118.46	4.70	72.64	15.39	64.48	3.53
	High	130.35	20.60	114.32	17.18	87.28	5.89	68.15	8.21

temporal. Furthermore, patients with hypermetropia also observed a decline in the mean RNFL thickness initiated by inferior, superior, nasal, and temporal thickness. The RNFL thickness for the inferior segment reported a significant difference between all three groups (p-value <0.0001). This signifies that the myopic eyes were reported to have thicker temporal RNFL and thinner inferior RNFL.

In addition, the RNFL thickness parameters of patients with myopic eyes demonstrated temporal deviations in the peak RNFL thickness, factors such as shorter scan time and line scanning ophthalmoscope.[17] In this study, the inferior RNFL thickness reported a significant difference between emmetropia and myopia (p-value <0.0001). The superior RNFL thickness also reported a significant difference between the myopic and emmetropic.

In our study, the inferior and superior RNFL regions were found to be thinner with a high mean prevalence of axial length in myopic patients, which was similar to the findings of Shin et al., and Choi et al.[12,13]

Hence, in myopic patients, RNFL thickness can be at a lower reading when compared with the actual thickness.

High myopes are likely to exhibit different RNFL distribution patterns. Since ocular magnification significantly affects RNFL measurement in such patients, it should be considered in diagnosing glaucoma.In early glaucoma, structural changes can result in functional damage of RNFL, one of the sensitive indicators for predicting early glaucomatous changes and assessing the RNLF damage correlation with the functional deficit in terms of the visual field (VF). The RNFL thickness assessment can be more beneficial than the optic nerve head assessment in patients with myopic changes.[18]

5. Conclusion

Myopic individuals exhibited significant RNFL thinning, particularly in the inferior and superior quadrants, resembling early glaucoma-related changes. In high grade of myopia, a larger deflection of axial length and RNFL thickness was noted. This has implications for glaucoma suspect evaluations. This should be taken into account while evaluating glaucoma suspects.

6. Source of Funding

None.

7. Conflicts of Interest

The authors declare no conflicts of interest.

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